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# Indoor-outdoor particle effects on health in middle-aged and elderly

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## SUMMARY

A series of 5 studies in a total of 300 middle-aged and elderly individuals have related exposure to indoor and outdoor ultrafine and fine particles for 5-48 h to effects on vascular and lung function with possible explanatory inflammation and oxidative stress biomarkers. The data consistently support detrimental effect of UFP from traffic on vascular function. Indoor UFP and PM<sub>2.5</sub> might contribute to cardiovascular risk through endothelial damage and vascular dysfunction, respectively, whereas indoor UFP dominated by candle burning appears to have adverse lung effects. The biomarkers provided no mechanistic explanation.

## PRACTICAL IMPLICATIONS

Reducing exposure to both outdoor and indoor ultrafine and fine particles can reduce adverse cardiovascular and lung effects

## 1 INTRODUCTION

Whereas a wide range of health effects related to outdoor particulate matter (PM) have been well described limited knowledge is available with respect to indoor PM, where sources are different. Specific focus has been laid on ultrafine particles (UFP) with traffic as main source outdoors, whereas indoor sources such as cooking, smoking and candle burning potentially dominate the total personal exposure. UFP are considered particularly adverse to health because of the small size favoring alveolar deposition, large surface area with reactive potential and adhering chemicals driving inflammation processes, as well as the potential to translocate to the systemic circulation. These mechanisms are thought to be involved in the lung and cardiovascular disease associated with exposure to PM and they can be demonstrated by changes in lung function, vascular function, circulating vascular endothelial cells and/or biomarkers of inflammation and oxidative stress.

## 2 MATERIAL /METHODS

We assessed associations between exposure to outdoor and/or indoor UFP and/or PM<sub>2.5</sub> and lung function, vascular function, circulating vascular endothelial cells and/or biomarkers of inflammation and oxidative stress in 5 studies involving almost 300 middle-aged and elderly non-smoking healthy individuals in total: i) controlled exposure to air from a busy street or filtered air for 5 h in 60 elderly overweight individuals (Hemmingsen et al. 2015); ii) home intervention with active or sham particle filtration for each of two weeks in random order with 49 elderly individuals (Karottki et al. 2013); a panel study with these participants and indoor and outdoor monitor measurements of UFP and PM<sub>2.5</sub> (Karottki et al. 2015) before each of 7 health-related measurement during winter (Karottki et al. 2015); cross-sectional study of 60 individuals relating 48-h indoor and outdoor monitor UFP and/or PM<sub>2.5</sub> measurement to health-related measurements during winter (Karottki et al. 2014); cross-sectional study of 80 individuals relating 48-h personal UFP and indoor and outdoor monitor UFP and PM<sub>2.5</sub> measurements to health-related measurements during spring (Olsen et al. 2014).

### **3 AND 4 RESULTS AND DISCUSSION**

Key findings include that outdoor levels of UFP were consistently across all 5 studies associated with decreased vascular function in keeping with particular cardiovascular adverse effect of diesel exhaust particles. There was no association between indoor UFP and vascular function, although the decrease in indoor PM<sub>2.5</sub> especially in the bedroom was associated with increased vascular function in the intervention study. However, indoor UFP were inversely associated with vascular endothelial stem cells indicating potential damage to the endothelium and risk of manifest cardiovascular disease although this was only measured in the second cross sectional study. These observations suggest that indoor fine particles and UFP also have cardiovascular effects. Indoor UFP were inversely associated with lung function in the two studies performed in the winter season and this appeared attributed to candle burning. In the study from the spring season there was minimum candle burning and no association between UFP and lung function. There were no clear and consistent associations between the exposure metrics and the biomarkers of oxidative stress and inflammation across studies although some statistically significant and biologically plausible associations were apparent in different studies.

### **5 CONCLUSION**

The collected information from this suite of studies lends further evidence to the detrimental effect of UFP from traffic on vascular function and the related risk of cardiovascular disease. Indoor UFP might contribute to cardiovascular risk through potential endothelial damage, whereas indoor UFP dominated by candle burning appears to have adverse lung effects. The biomarkers of oxidative stress and inflammation provided no mechanistic explanation.

### **ACKNOWLEDGEMENT**

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